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ABSTRACT

During the academic year 1972-1973, an Introductory Interdisciplinary Course in Natural Sciences, Natural Sciences 101-102, was offered as a voluntary alternative to the traditional separate courses in physics, biology, and chemistry, for a group of 60 students. The method of selection of the students, the organization of the course, and the criteria used for evaluation of the course are fully described, together with conclusions and recommendations for future developments. The overall conclusion is that this course provided an exciting and valid alternative to the more conventional courses, and that it has provided an important stimulus to future planning of the natural sciences curriculum. (Author/LS)

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FINAL REPORT

SE

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Project No. IB101

Grant No. OEG 2 71-0101

Amador Cobas

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Río Piedras, P.R. 00931

INTRODUCTORY INTERDISCIPLINARY COURSE IN THE NATURAL SCIENCES

JANUARY 1974

U.S. DEPARTMENT OF HEALTH, EDUCATION AND WELFARE

Office of Education

National Center for Educational Research and Development

(Regional Research Program)

SE 019 089

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Amador Cobas
University of Puerto,Río Piedras Campus
Río Piedras,P.R. 00931

January 1974

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National Center for Educational Research and Development

TABLE OF CONTENTS

I. INTRODUCTION

II. METHODOLOGY

1. General Characteristics

2. Selection of Participating Students

3. Topics

4. Evaluation

5. Participating Professors

III. RECOMMENDATIONS AND OBSERVATIONS

IV. ACKNOWLEDGEMENTS

V. APPENDICES

I. Introduction

During the academic year 1972-73, the Natural Sciences Faculty of the UPR Rio Piedras campus, offered to sixty of its second year students an interdisciplinary course under the name "Natural Sciences 101-102". This course substituted the normal introductory courses in Biology, Chemistry, and Physics which are required for all students in Natural Sciences. Professors from the three departments concerned collaborated in the design and implementation of the course which was administratively assigned to the Dean's office.

Economic support for the development of the course came from a grant of $10,000.00 from the Department of Health, Education and Welfare (HEW) of the Federal Government, matched by the UPR in Faculty salaries and services needed by the program.

The idea of an interdisciplinary course at an introductory level is not new, and there are numerous antecedents. Considering only the North American Educational System in the last ten years, one finds more than 40 institutions which have offered interdisciplinary courses in Natural Sciences with very varied programs, formats and objectives. In general, the results of these experiments have not been very striking. In spite of this, a course of this nature offers sufficient educational possibilities to justify its use, especially keeping in mind that there do not exist unique and exclusive solutions to problems in teaching.

Presentations which were made in proposing the course stem in part from general educational problems and in part from specific problems in the teaching of the Natural Sciences Faculty of the UPR in Rio Piedras. Basically, they can be summarized in the following form:

1. For years the educational tendency has beer. to specialize the students at the earliest stage possible. This process has reached such a point that the students enter the faculty decided to specialize in a predetermined field, knowing almost nothing about what it consists of, and ignoring almost completely the options which they are denying themselves as a consequence of this decision.

2. The separate introductory courses in Biology, Chemistry and Physics unknowingly support the natural tendency of the student to give priority to the material in which he thinks of specializing, to the detriment of the other basic courses. This problem can be seen in its full dimension if we realize that in our particular case the student is not required to take the three basic courses in his first year in the faculty. As a matter of fact, a high percentage take two of them, generally Biology and Chemistry or Biology and Physics, leaving the third for later years. The consequences are in many cases a deficient preparation, a loss of educational opportunity not only at a personal level but also at an institutional level, and a delay in completion of the student's studies.

3. It is necessary to convince the students that Science is an indivisible whole that specialization is not a requirement of nature but a painful necessity coming from the human incapacity to absorb all the fields of knowledge. The idea of unity in Science runs a great risk of being lost in the traditional basic courses, since these, by their very nature, are limited to presenting partial aspects. It can occur, as has in fact happened, that the trees hide the wood.

4. An integrated course presents, a priori, the advantage of being able to avoid unconnected and often sterile repetitions, which the separated course system imposes. This permits the teaching to be more compact, funcional, and in consequence, more effective. In the case of the Natural Sciences Faculty of the UPR this aspect is particularly important if we remember that the different departments have available a minimum number of credit- hours to prepare their students, due to the number of required courses that the students must take outside the faculty.

5. An integrated course can serve, with or without modifications, for students of other faculties interested in a nontrivial introductory course in Science. For example, it is convenient to indicate that the Pharmacy students are required to take the basic courses in Natural Sciences. It is also important to keep in mind that of the students admitted to the faculty of Natural Sciences, more than 60% have the intention of studying medicine or associated careers. Any reduction which can be realized in the basic programs of Natural Sciences without loss of effectiveness in teaching, resounds to the benefit of those students.

II. Methodology

1. General Characteristics

The course was developed in three hour sessions with an intermediate break of 15 minutes, five days a week for two semesters, each carrying 12 credits: exactly equal to the number of credits which are obtained taking the equivalent three basic courses in Natural Sciences.

The personnel assigned to the program consisted of three fixed professors, four in the second semester, one for each department directly affected by the project except Chemistry, which in the second semester provided two, and a secretary. For the presentation of some specific topics the collaboration was obtained of various professors in the Science Faculty and the Puerto Rico Nuclear Center, appearing as invited lecturers in the program.

During the first semester, the three fixed professors attached to the program attended all the sessions, and actively participated in discussions in the classroom, making suggestions and clarifications on specific points, and alternating in the presentation of the topics. In spite of the excellent results obtained, this system could only be used sporadically in the second semester due to commitments of the professors in other university programs.

In the presentation of the topics, an open system was used in which every one, professors and students, could interrupt the lecture to ask questions, present explications, demonstrations

or different examples from those used by the lecturer to clarify a particular point. In the beginning it was attempted to use the first part of each session to explain the corresponding material without interruptions, keeping the second part for discussion, questions, and difficulties. However, it was noted that this procedure slows up the progress of the course, and tended to leave obscure points in the explications which stop the student from following the rest of the lecture. Thus, this method eas discarded in favor of the method indicated above. Audiovisual techniques were used as much as possible.

Almost all the topics covered in the course were handed over to the students in mimeographed from, leaving only the work of looking in the library for information on certain specific topics, in which case concrete and clear references were given so that the student could carry out this work without difficulty. The reason for using this method was the impossibility of finding a text which could be adjusted to the neccessities of the course.

2. Selection of the participating students

In the Spring of 1972 all students who had solicited admission to the Natural Sciences Faculty were informed of the existence of the program, thru a letter to that effect, (see Appendix 1). Later, the same students were handed a questionaire requesting their collaboration, (see Appendix 2). Of 526 questionnaires received 215 indicated interest in participating in the course. Of these 100 were automatically excluded by not obtaining 50% in the mathematical session of the diagnostic exam

that the Faculty of Natural Sciences administered to all its applicants. This criteria had been recommended as a requisite for admission to the faculty by the corresponding faculty committee. (For reasons which are not important here, the faculty did not apply this condition in an absolute way in its admission, although the course did do this in its selection).

The 115 candidates to the course were called to a meeting, only 60 attended which automatically eliminated the problem of having to make a new selection. At the moment of matriculation only 59 appeared, since one student was called for military service, and of these three transfered their studies to universities in the United States during the first week of classes. Thus, the group was reduced to 57, which constituted the official enrollment of the course for the first semester. Appendix 3 contains the list of the 60 students originally selected, with the academic information which was available at the beginning of the school year 1972-73.

3. Topics

The topics developed in the course can be summarized in the folling outline:

1. Natural Systems: Ecosystems
2. Macroscopic properties of Natural Systems:
   Thermodynamics
   Classical Mechanics
   Kinetic Theory of Gases
   Statistical Mechanics
   Interchange of Energy in Living Systems

3. Microscopic Properties of Natural Systems:

   Waves and Particles

   The Electromagnetic Field

   Quantum Mechanics

   Elementary Particles

   The Nucleus

   The Atom

4. Properties of Systems in Agreggated States:

   Molecular Structure: Bonding

   The Solid State

   The Liquid State

   The Gaseous State

5. The Periodic System:

   Elements, Compounds and Transformations

6. Macromolecular Structures:

   Carbon Chemistry

   Macromolecules and Polymers

   Molecular Biostructures

   Celular Ultrastructure

7. Chemical Dynamics

   Kinetics and Reaction Mechanisms

   Reactions with Proton Transfer

   Reactions with Electron Transfer

8. Cellular Respiration

   Photosynthesis

9. Structure and Function of Living Organisms

10. Homeostasis, Control, Integration and Regulation Mechanisms

11. Mendelian and Populational Genetics

12. Organic Evolution

13. The Origin of Life

In Appendix 4 are included the materials delivered to the students during the course, as well as the references used or recommended for certain specific topics. This shows in a concrete way the level and range of the topics indicated above.

The experimental part of the course consisted of three weeks in the Biology, Chemistry and Physics Laboratories, carrying out a selection of the experiments which are used by the students in the regular courses, two sessions over the use of computers in scientific work, and three special projects directed by invited professors from the graduate faculty of the three departments involved in the project. (See Appendix 5.)

4. Evaluation

In this section there are two aspects involved which, although linked, it is convenient to differentiate from the beginning: the evaluation of the student, from the point of view of grade, and evaluation of the program as such.

The first aspect only supposes certifying, by means of a grade, the level of proficiency of the students in the material covered in the course. For this the students took nine exams, four in the first semester and five in the second. Due to the experimental nature of the program and the number of credits

which were involved, it was decided that every person who obtained less than 50% of the correct answers in any of these exams should be obliged to take a repetitive test as many times as should be necessary, until they were able to demonstrate a minumum knowledge of the material involved in the exam. Students with less than 60% of the correct answers were advised that they should voluntarily take the corresponding test. This assured the students that if they made the necessary effort, their grade would not be lower than C. On the other hand, a student would not see his average affected by failing one particular exam, since he would always have a second opportunity.

At the end of the first semester, by an agreement between the students and the professors, it was decided to give the same grade in both semesters. This gave a better perspective of the progress of each student at the time of giving the grade and helped students with erratic or deficient grades in the exams to take the auxiliary test without great pressure of time. Towards the end of the second semester, at the petition of the students, the corresponding academic authorities authorized the use of the grades "Pass" or "Fail" in place of the five normal grades. The reason for this decision will be discussed further on in this report. Under these circumstances all the participating students obtained the grade of "Pass" in both semesters.

The second aspect of the evaluation, that of the program, assumes determining its efficiency, not only in preparing students to take more advanced courses, but also in providing them with firm and clear criteria both in the scientific and human

aspects. This has serious difficulties, since on one hand, it requires the professors to be judges of their own work; on the other hand, the methods of measurement which have been used are always indirect, and plagued with a high degree of uncertainty. In addition the precise evaluation of the program needs a follow-up of the participants. The results of this survey are obviously not available at this moment.

Tables 1 thru 9 and the corresponding graphs, show the statistics for the individual exams, without taking into account the complementary exams. Table 10 shows a summary of each semester separately and the complete course. All the exams were multiple choice, since this helped extraordinarily the analysis of the results. In no case was the index of reliability lower than 0.80. Analysis of the results of the individual exams, (see figures 5 and 11), gives a clear picture of homogeneity except in two cases: One in the first semester, which is above average, and the other in the second semester, which is below average. The same homogeneity appears on comparing the results of both semesters and the total of the course. The small discrepancy which exist between the results of both semesters (the average of the first is higher than that of the second) can be attributed to the change of the system of presentation of the topics which was indicated in section 1, as well as the perturbing effect of the two exams which were out of the normal range.

If we take 50% as the inferior limit of the grade of C, we find that the number of students with D, F or leaving the course, our 2 of the 56, (3.5%), during the first semester, 3 out of 54,

Test No. 1 1st Semester

No. of students considered: 50

No. of items in the exam.: 60 , Mean: 39.20, Stand.dev.:8.62

Grade	Grade(%)	Frequency	Frequency(%)
58	97	1	2
55	92	1	2
53	88	1	2
52	85	1	2
50	83	1	2
49	82	4	8
48	80	1	2
47	78	1	2
46	77	2	4
45	75	1	2
44	73	3	6
43	72	1	2
42	70	1	2
40	67	3	6
39	65	5	10
38	63	4	8
37	62	2	4
36	60	1	2
35	58	2	4
34	57	2	4
33	55	1	2
32	53	1	2
31	52	1	2
30	50	1	2
29	48	2	4
28	47	2	4
27	45	1	2
24	40	1	2
22	37	1	2
19	32	1	2

TABLA 1

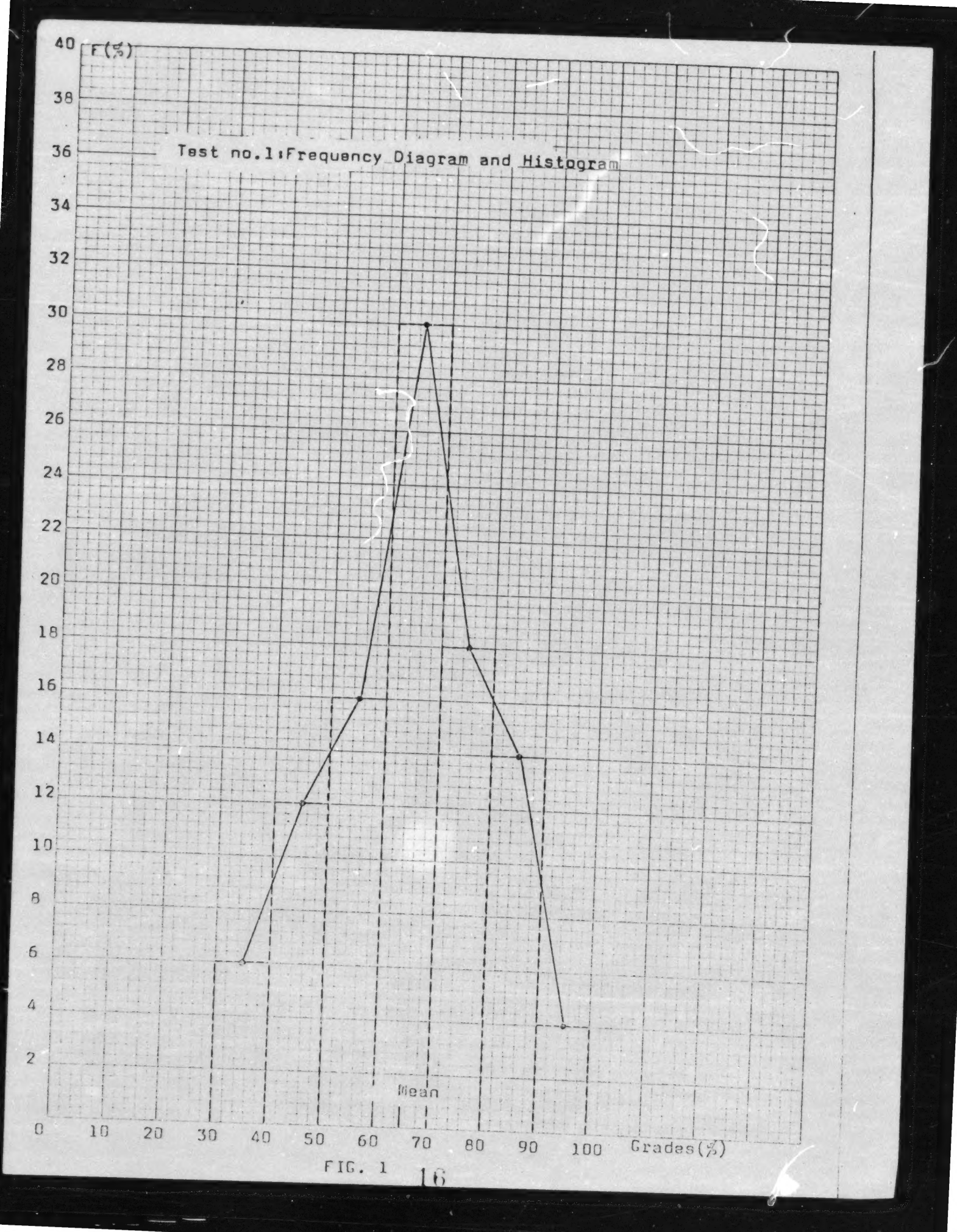

F(%)
Test no.1:Frequency Diagram and Histogram
40
38
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
10
20
30
40
50
60
70
80
90
100
Grades(%)
Mean

FIG. 1

Test No. 2 1st Semester

No. of students considered : 50

No. of items in the exam.: 35, Mean: 25.8 , Stand.dev.:4.57

Grade	Grade(%)	Frequency	Frequency(%)
34	97	1	2
33	94	2	4
32	91	1	2
31	89	3	6
30	86	3	6
29	83	7	14
28	80	2	4
27	77	5	10
26	74	5	10
25	71	2	4
24	67	6	12
23	66	3	6
22	63	2	4
20	57	2	4
19	54	2	4
18	51	2	4
15	43	2	4

TABLE 2

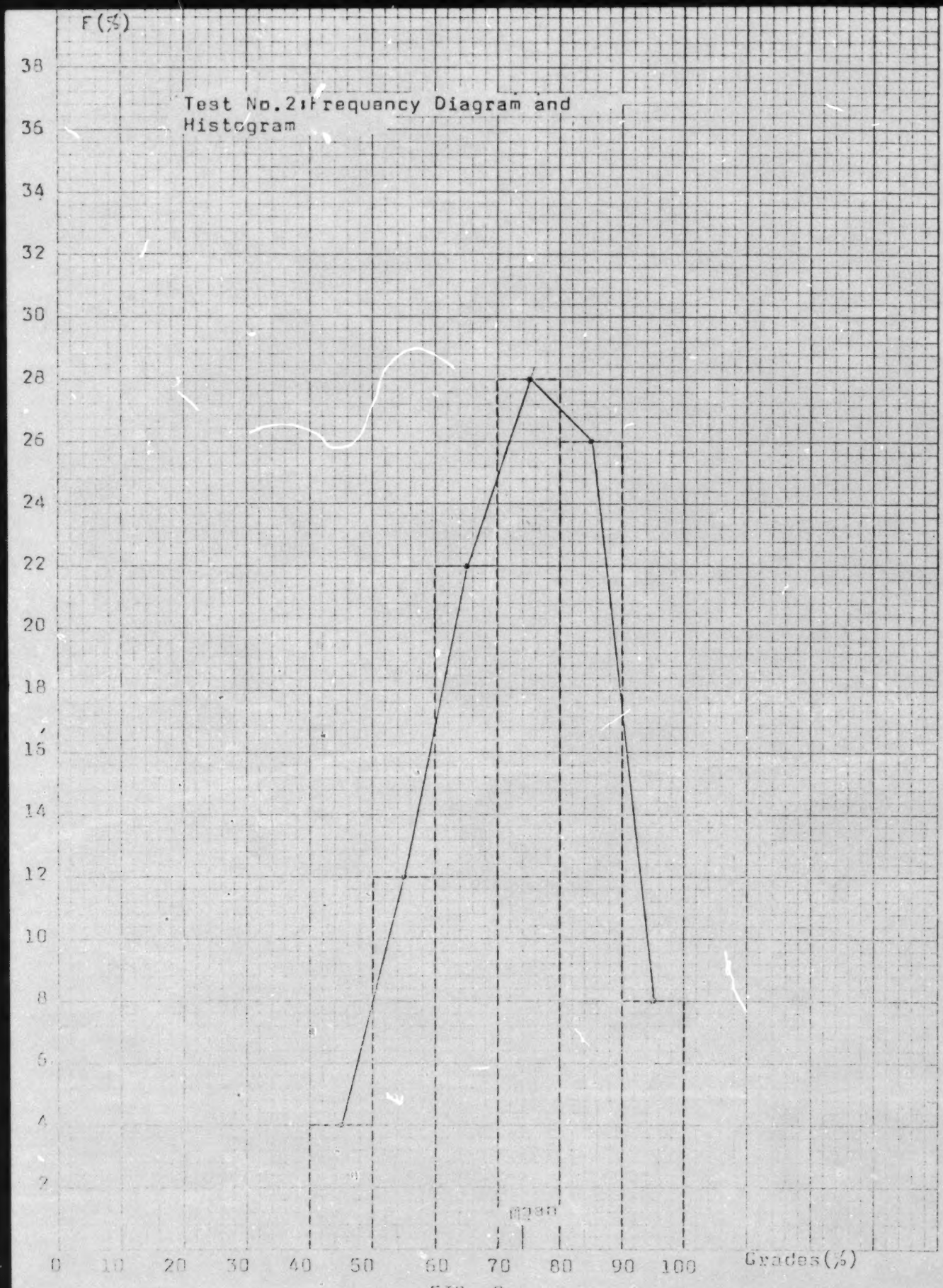

F(%)
Test No.2: Frequency Diagram and Histogram
38
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
10
20
30
40
50
60
70
80
90
100
Grades(%)

FIG. 2

Test No. 3 1st Semester

No. of students considered : 49

No. of items in the exam.: 80, Mean:65.75, Stand.dev.:6.31

Grade	Grade(%)	Frequency	Frequency(%)
74	93	3	6.12
73	91	2	4.08
72	90	3	6.12
71	89	2	4.08
70	88	3	6.12
69	86	3	6.12
68	85	6	12.24
67	84	4	8.16
66	83	4	8.16
65	81	3	6.12
64	80	2	4.08
63	79	3	6.12
62	78	3	6.12
61	76	1	2.04
60	75	2	4.08
59	74	2	4.08
54	68	1	2.04
47	59	1	2.04
41	51	1	2.04

TABLE 3

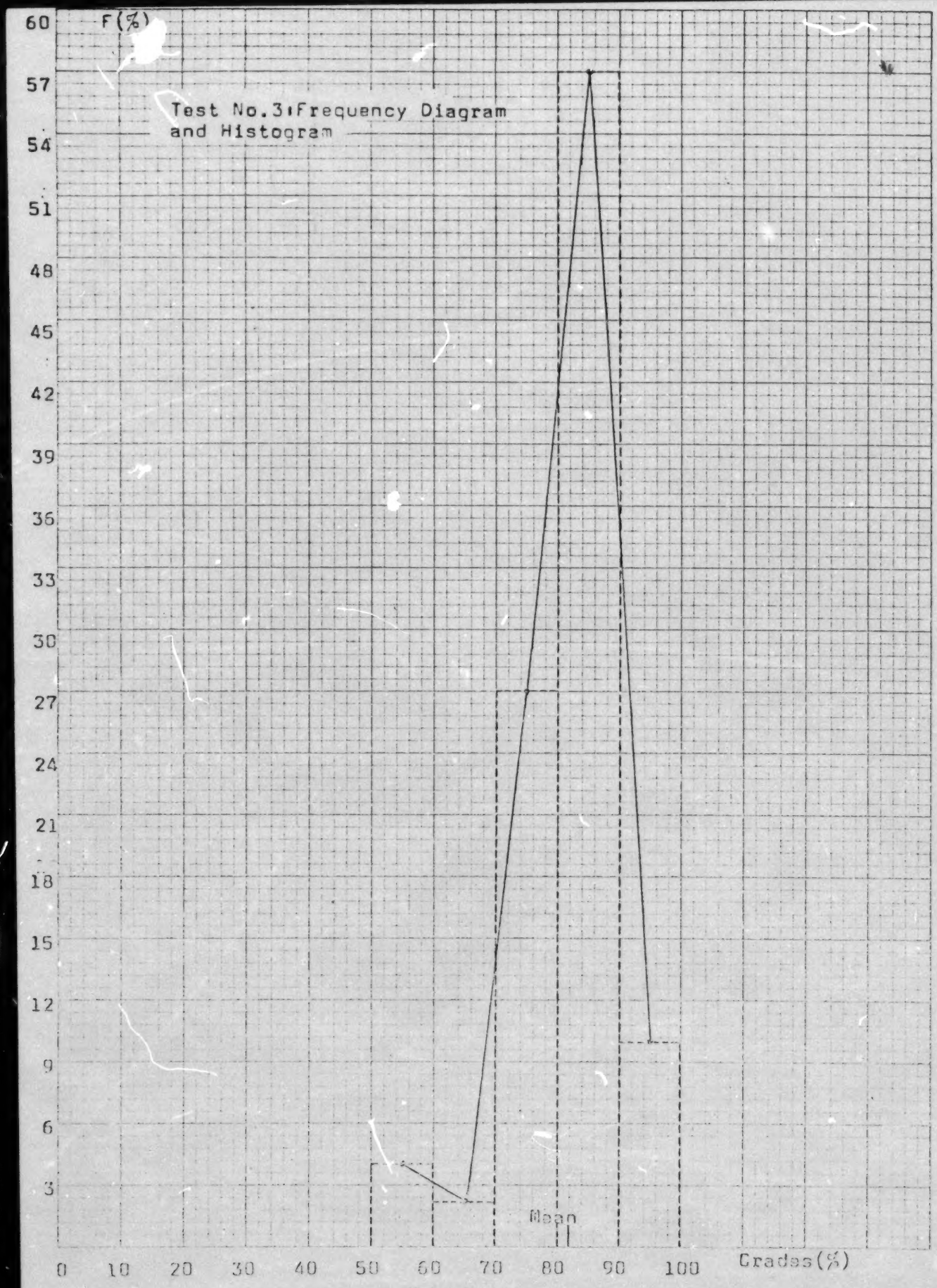

F(%)
Test No.3 Frequency Diagram and Histogram
60
57
54
51
48
45
42
39
36
33
30
27
24
21
18
15
12
9
6
3
Mean
0
10
20
30
40
50
60
70
80
90
100
Grades(%)

FIG. 3

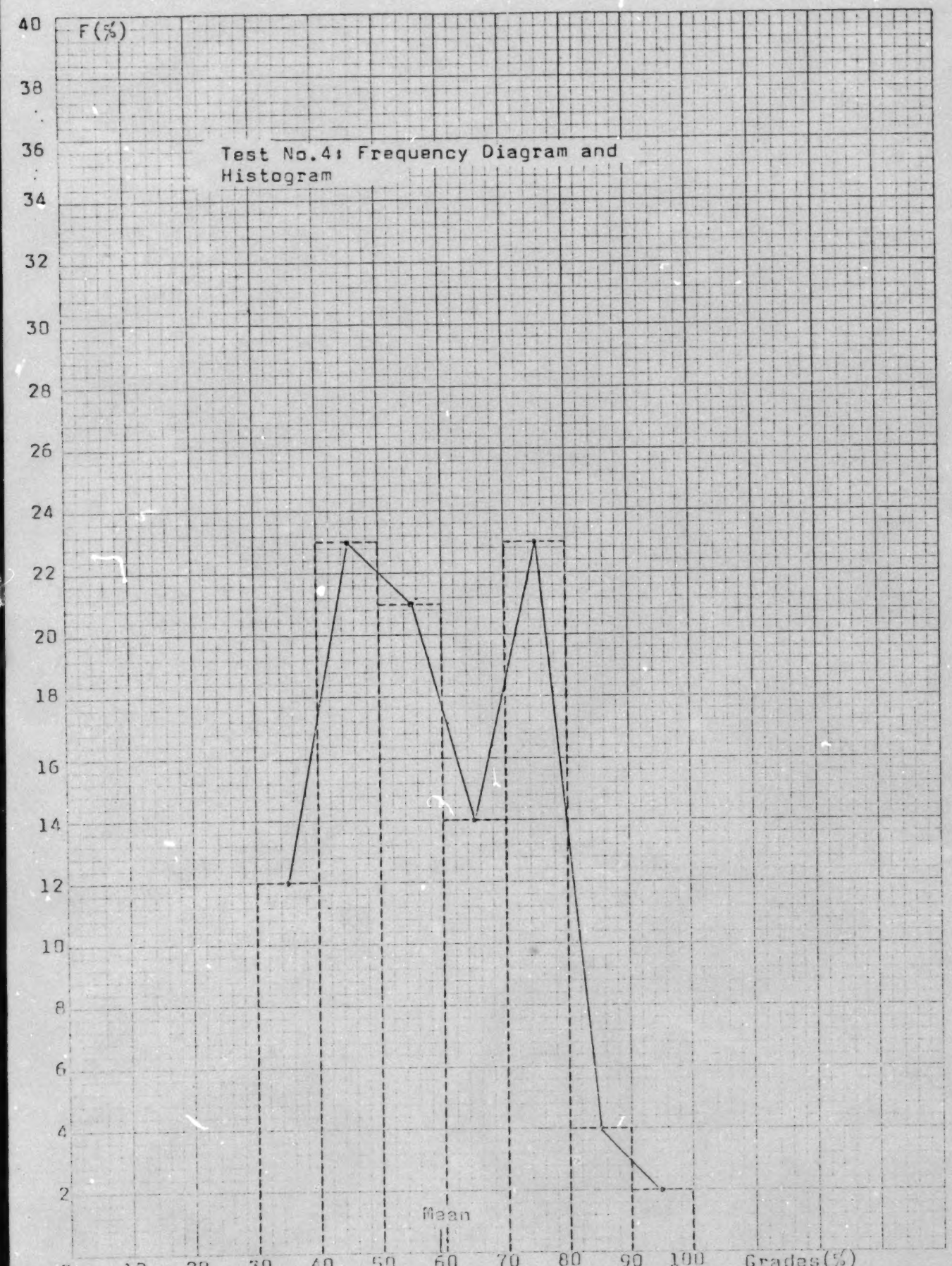
Test No. 4 1st Semester

No. of students considered : 49

No. of items in the exam.: 30, Mean: 17.77, Stand.dev.: 4.87

Grade	Grade(%)	Frequency	Frequency(%)
30	100	1	2.08
25	83	2	4.16
24	80	4	8.33
23	77	2	4.16
22	73	5	10.41
21	70	1	2.08
20	67	3	6.25
19	63	3	6.25
18	60	2	4.16
17	57	4	8.33
16	53	4	8.33
15	50	4	8.33
14	47	3	6.25
13	43	4	8.33
12	40	1	2.08
11	37	1	2.08
10	33	2	4.16
9	30	2	4.16

TABLE 4



Test No.4: Frequency Diagram and Histogram

FIG. 4

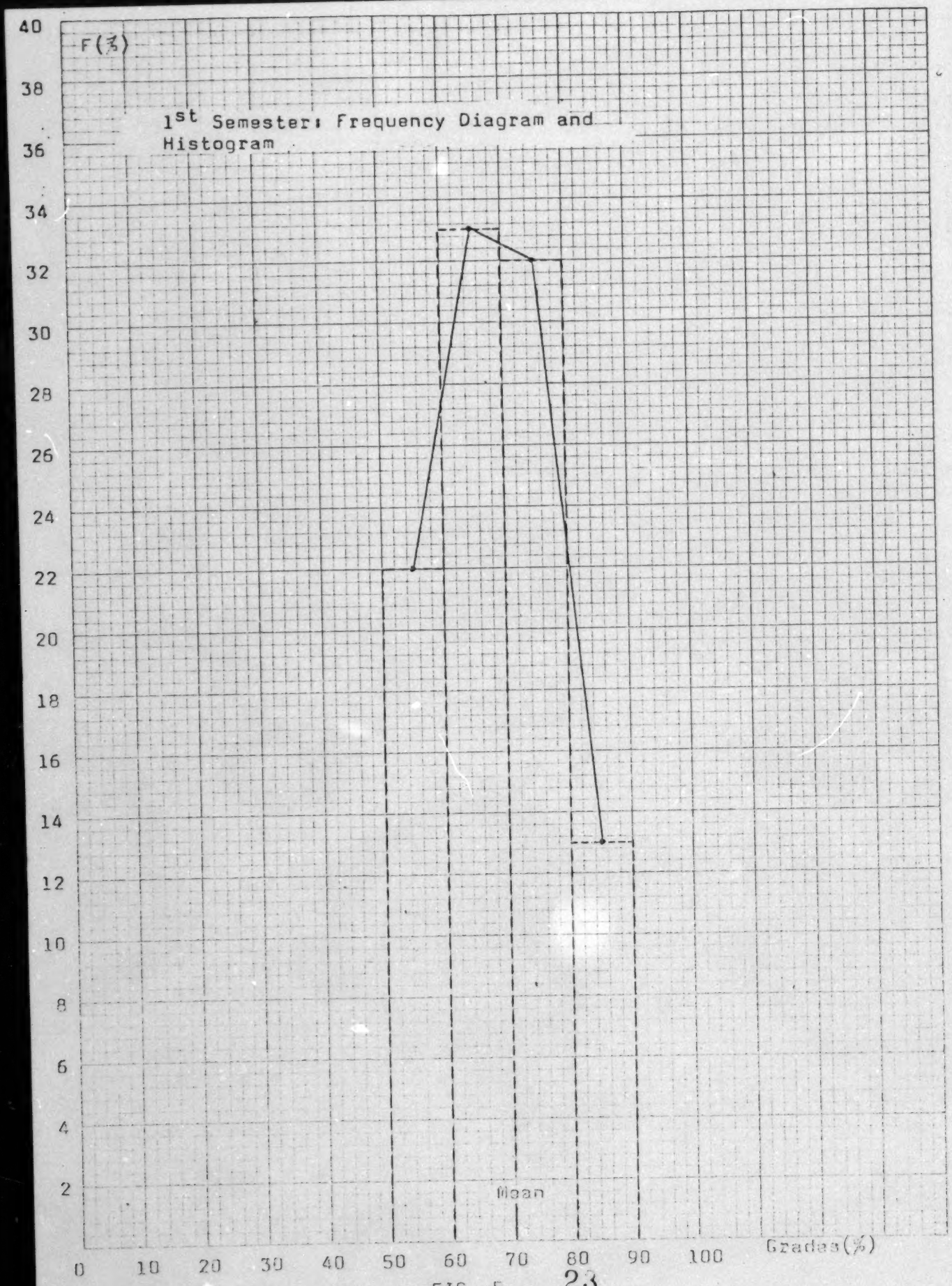

F(%)
1st Semester: Frequency Diagram and Histogram
40
38
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
Mean
0
10
20
30
40
50
60
70
80
90
100
Grades(%)

FIG. 5

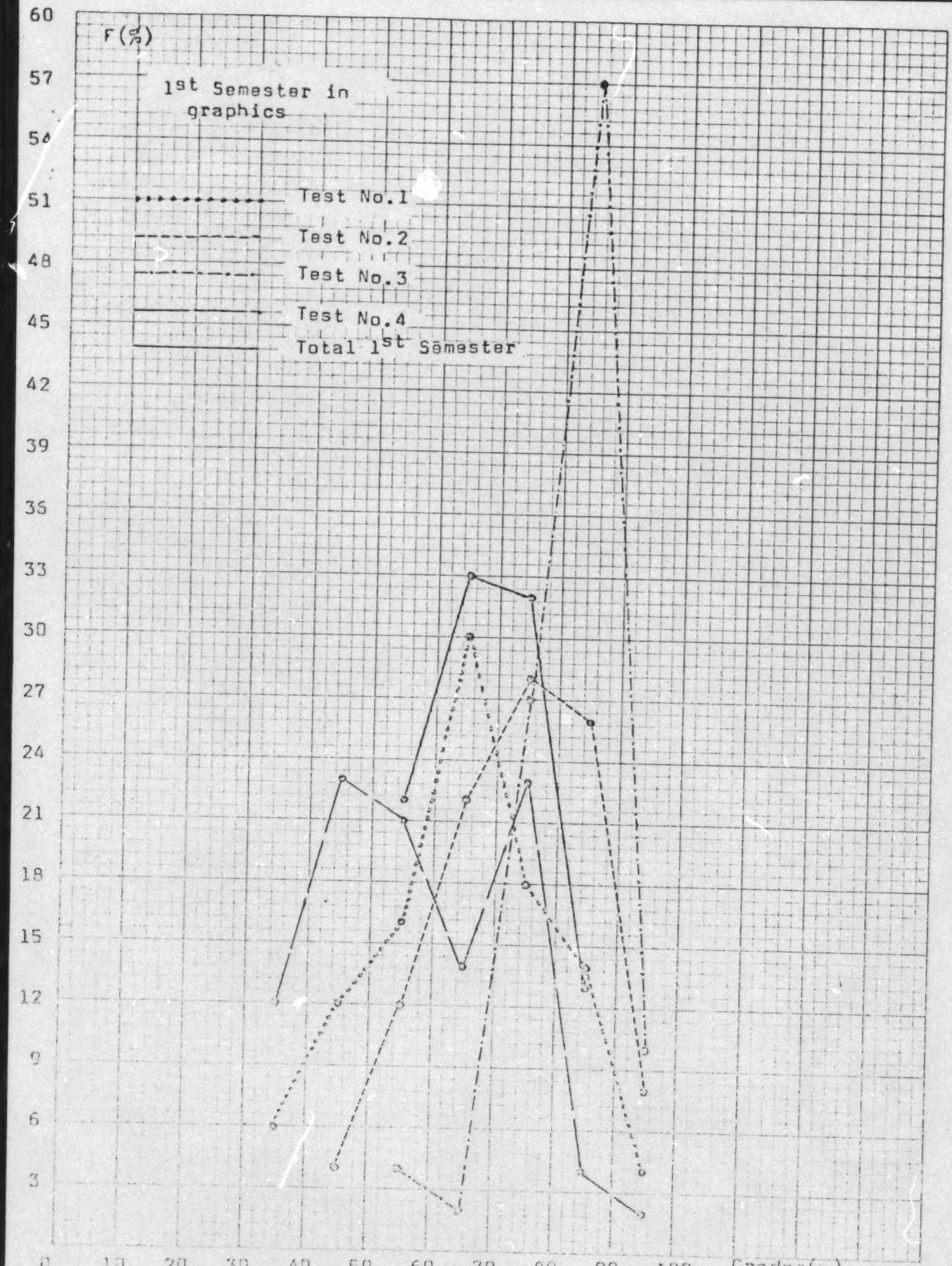

F(%)
1st Semester in graphics
Test No.1
Test No.2
Test No.3
Test No.4
Total 1st Semester
60
57
54
51
48
45
42
39
36
33
30
27
24
21
18
15
12
9
6
3
0
10
20
30
40
50
60
70
80
90
100
Grades(n)

FIG. 5 bis

Test No. 5 2nd Semester

No. of students considered : 46

No. of items in the exam.: 50, Mean: 39.96, Stand.dev.: 4.02

Grade	Grade(%)	Frequency	Frequency(%)
47	94	1	2.17
46	92	1	2.17
45	90	4	8.69
44	88	4	8.69
43	86	1	2.17
42	84	6	13.04
41	82	6	13.04
40	80	5	10.87
39	78	5	10.87
38	76	2	4.34
37	74	1	2.17
36	72	5	10.87
34	68	2	4.34
32	64	1	2.17
31	62	1	2.17
29	58	1	2.17

TABLE 5

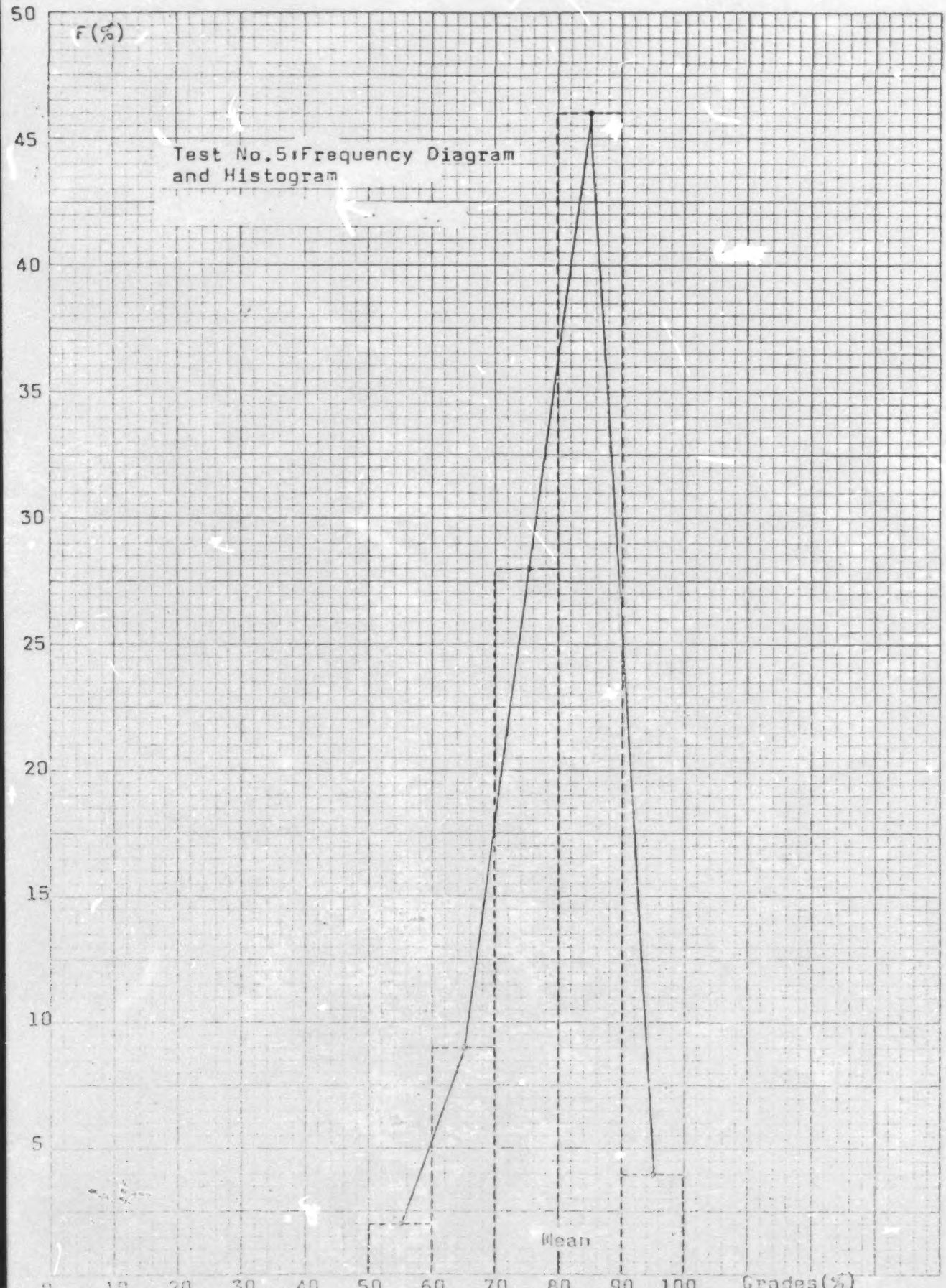

F(%)
Test No.5 Frequency Diagram and Histogram
50
45
40
35
30
25
20
15
10
5
0
10
20
30
40
50
60
70
80
90
100
Grades(%)
Mean

FIG. 6

Test No. 6 2nd Semester

No. of students considered : 52

No. of items in the test: 35 , Mean: 24.5[illegible], Stand.dev.:5.04

Grade	Grade(%)	Frequency	Frequency(%)
32	91	2	3.84
31	89	3	5.76
30	86	4	7.69
29	83	6	11.53
28	80	6	11.53
27	77	2	3.84
26	74	3	5.76
25	71	5	9.61
24	69	2	3.84
23	66	7	13.46
22	63	1	1.92
21	60	1	1.92
20	57	3	5.76
18	51	2	3.84
17	49	1	1.92
14	40	3	5.76
12	34	1	1.92

TABLE 6

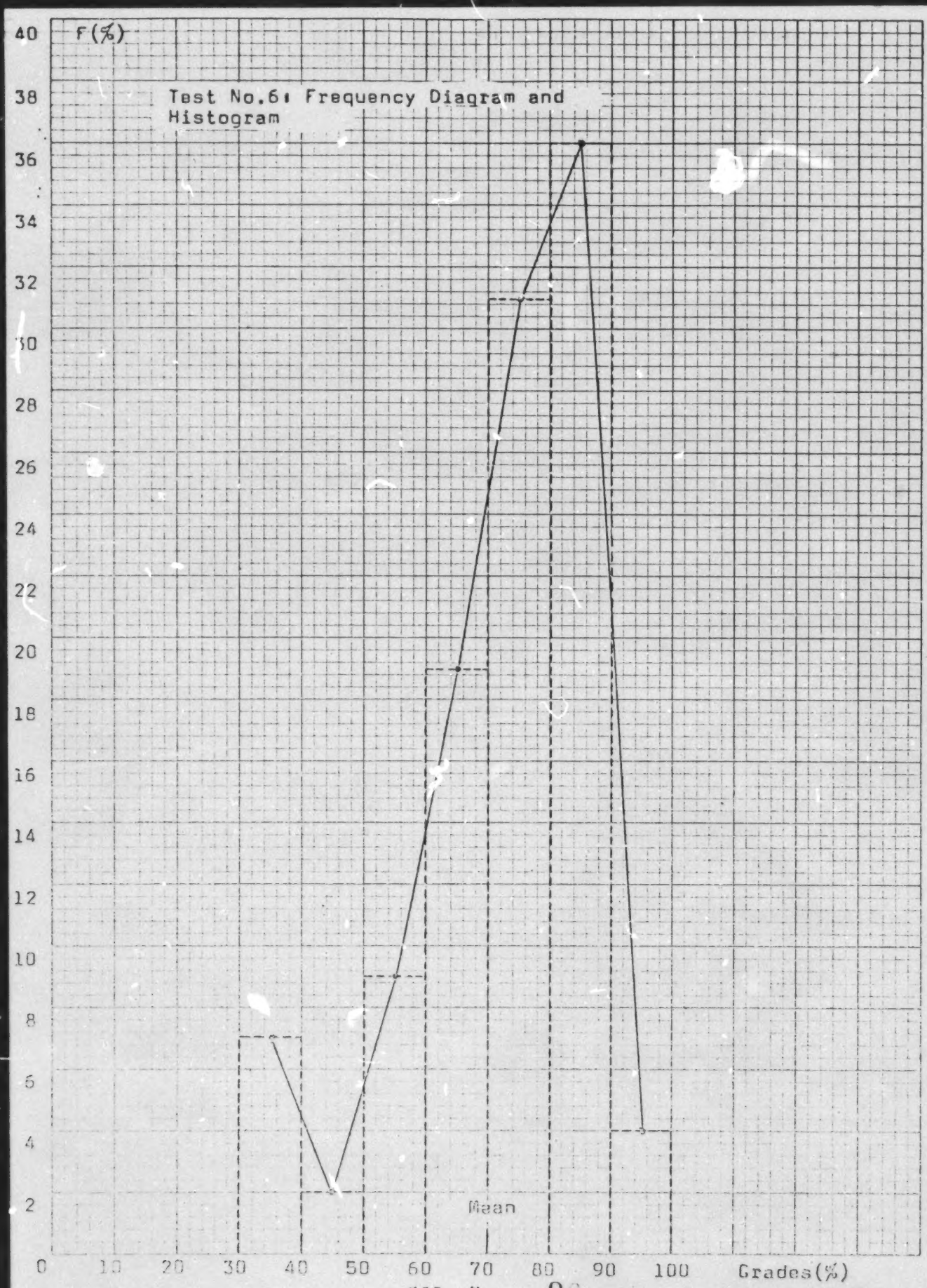

F(%)
Test No.6: Frequency Diagram and Histogram
40
38
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
10
20
30
40
50
60
70
80
90
100
Grades(%)
Mean

FIG. 7

Test No. 7 2nd Semester

No. of students considered : 46

No. of items in the test:95 , Mean:55.61 , Stand.dev.:11.73

Grade	Grade(%)	Frequency	Frequency(%)
80	84	1	2.17
78	82	2	4.35
72	76	1	2.17
71	75	1	2.17
70	74	1	2.17
68	72	2	4.35
67	71	1	2.17
65	68	1	2.17
64	67	2	4.35
63	66	1	2.17
62	65	3	6.52
61	64	1	2.17
60	63	1	2.17
59	62	2	4.35
55	58	4	8.70
54	57	3	6.52
53	56	2	4.35
51	54	1	2.17
50	53	1	2.17
49	52	1	2.17
48	51	1	2.17
47	49	2	4.35
46	48	1	2.17
45	47	2	4.35
44	46	1	2.17
43	45	1	2.17
42	44	1	2.17
41	43	1	2.17
38	40	1	2.17
36	38	1	2.17
34	36	1	2.17
31	33	1	2.17

TABLE 7

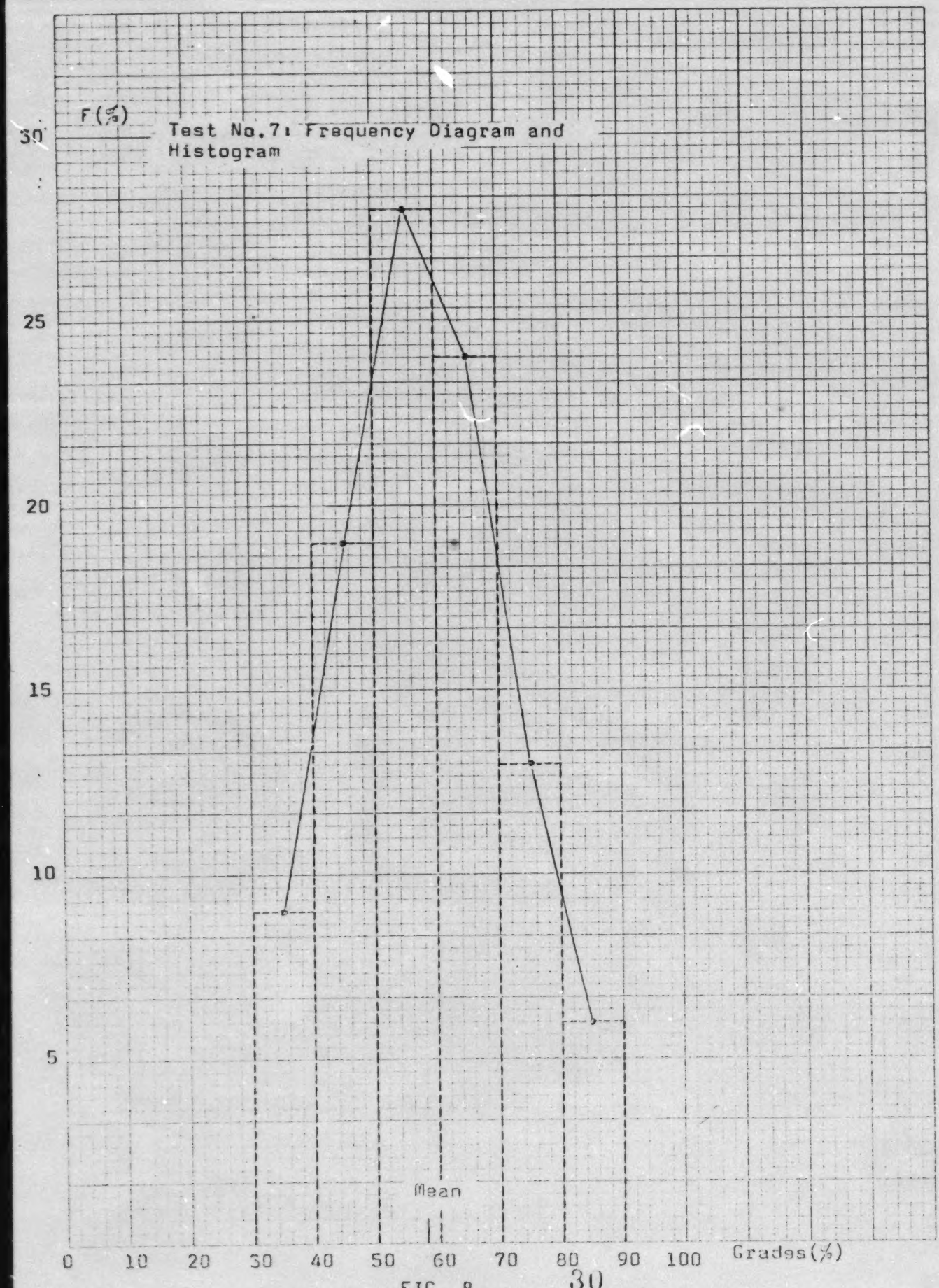

F(%)
Test No.7: Frequency Diagram and Histogram
30
25
20
15
10
5
Mean
0
10
20
30
40
50
60
70
80
90
100
Grades(%)

FIG. 8

Test No. 8 2nd Semester

No. of students considered : 50

No. of items in the test:27,Mean:14.13,Stand.dev.:4.30

Grade	Grade(%)	Frequency	Frequency(%)
25	93	1	2
22	81	1	2
21	78	1	2
20	74	6	12
19	70	1	2
18	67	2	4
17	63	4	8
15	56	4	8
14	52	6	12
13	48	5	10
12	44	6	12
11	41	3	6
10	37	5	10
9	33	1	2
8	30	1	2
7	26	2	4
5	19	1	2

TABLE 8

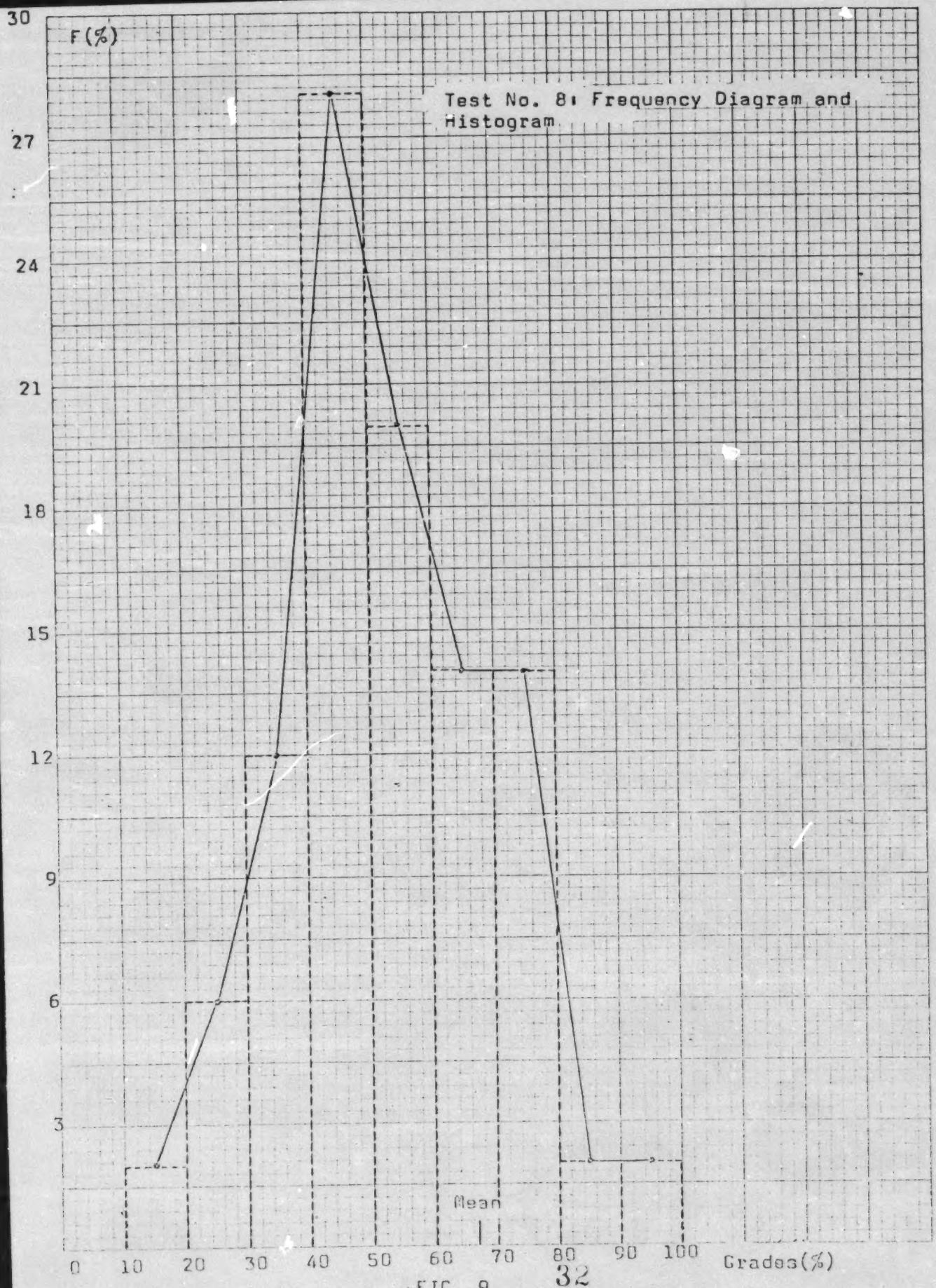

F(%)
30
27
24
21
18
15
12
9
6
3
Test No. 8: Frequency Diagram and Histogram
Mean
0
10
20
30
40
50
60
70
80
90
100
Grades(%)

FIG. 9

Test No. 9 2nd Semester

No. of students considered: 34

No. of items in the test:100,Mean:67.41,Stand.dev.:10.50

Grade	Grade(%)	Frequency	Frequency(%)
91	91	1	2.94
87	87	2	5.88
82	82	1	2.94
79	79	1	2.94
78	78	2	5.88
77	77	2	5.88
74	74	1	2.94
72	72	2	5.88
71	71	1	2.94
70	70	2	5.88
66	66	2	5.88
65	65	2	5.88
64	64	3	8.82
63	63	5	14.71
58	58	1	2.94
56	56	2	5.88
53	53	1	2.94
49	49	1	2.94
44	44	1	2.94
42	42	1	2.94

TABLE 9

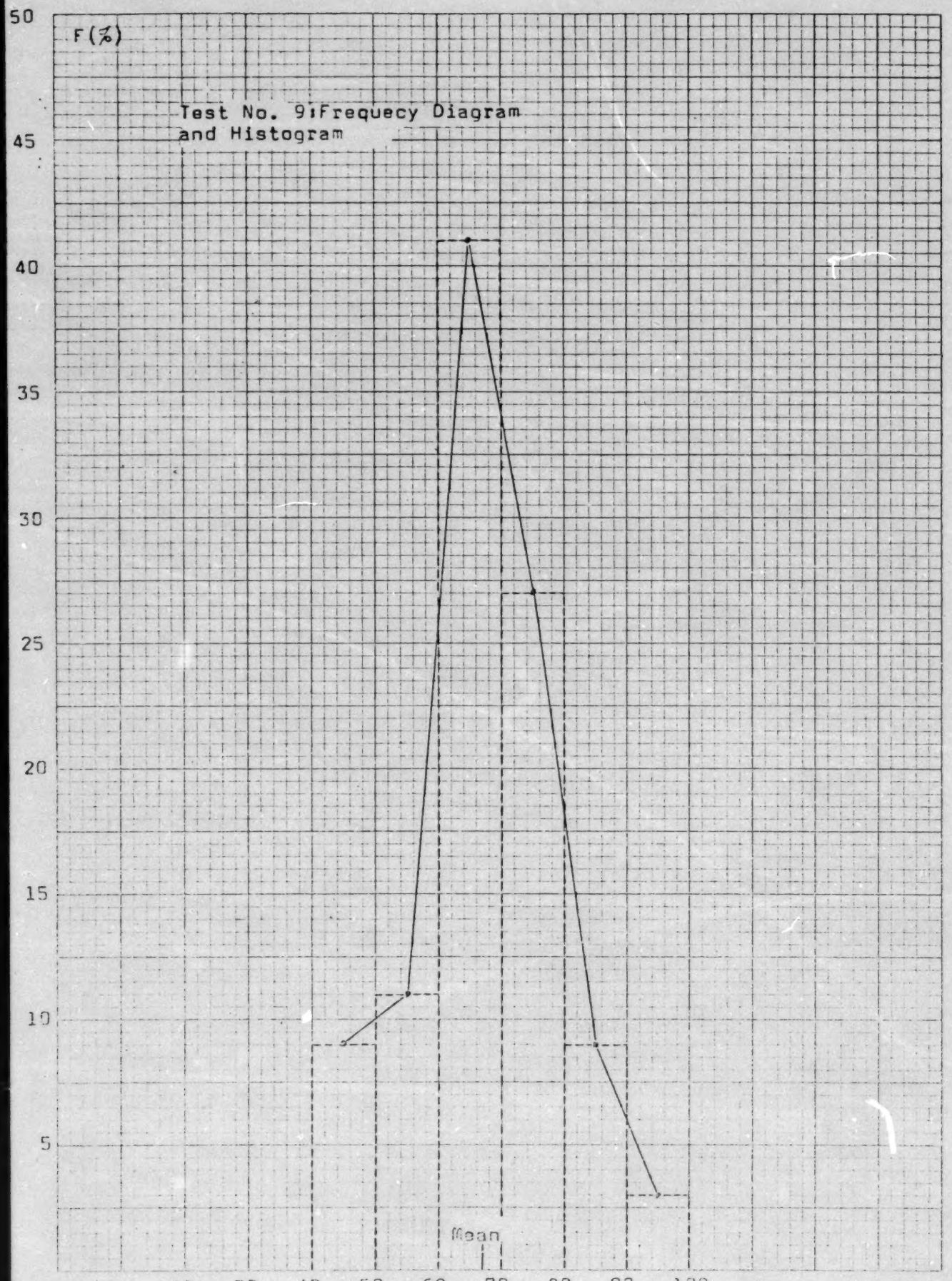

F(%)
Test No. 9 Frequecy Diagram and Histogram
50
45
40
35
30
25
20
15
10
5
0
10
20
30
40
50
60
70
80
90
100
Mean
Grades(%)

FIG. 10

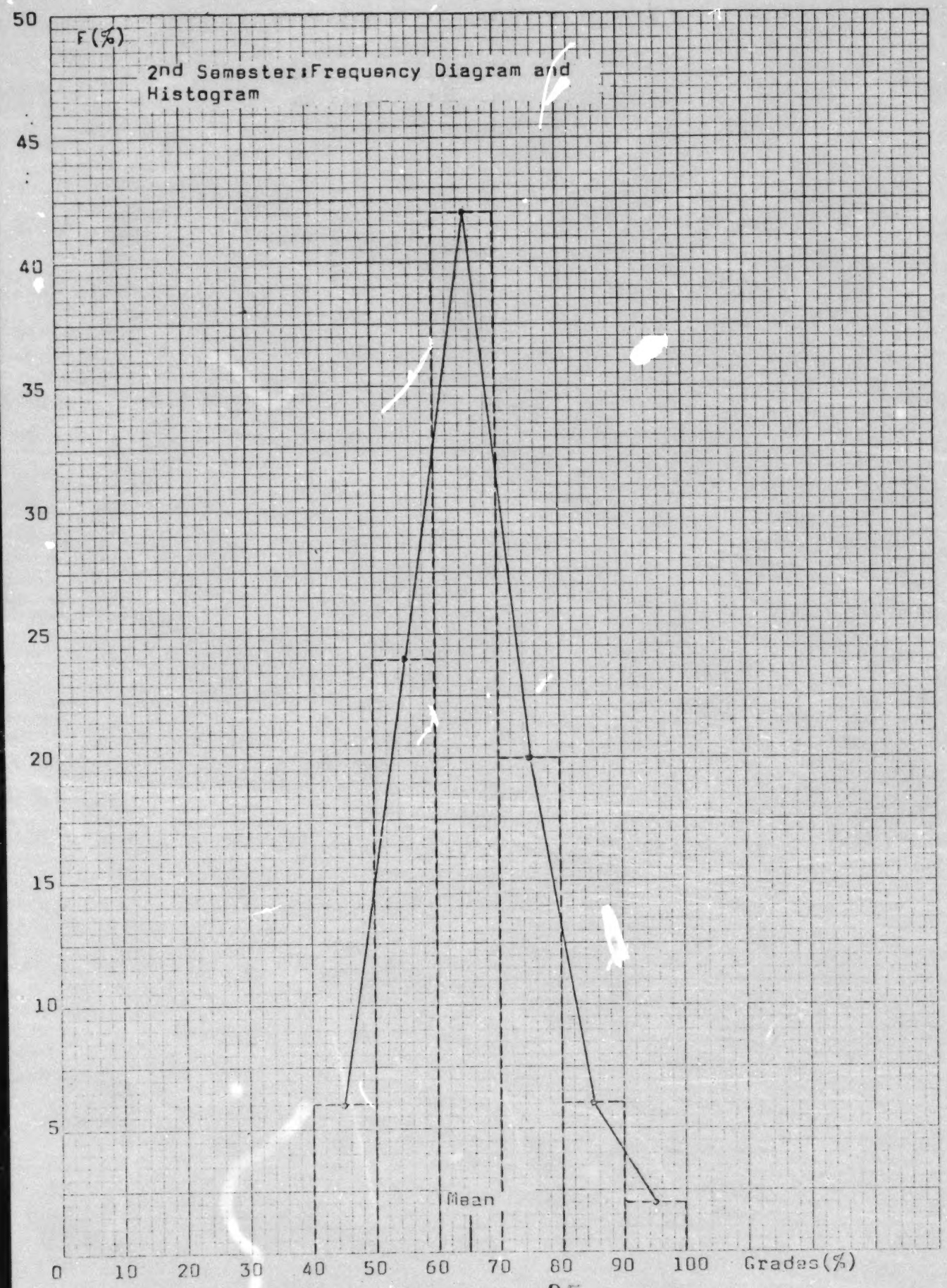

F(%)
2nd Semester: Frequency Diagram and Histogram
50
45
40
35
30
25
20
15
10
5
0
10
20
30
40
50
60
70
80
90
100
Grades(%)
Mean

FIG. 11

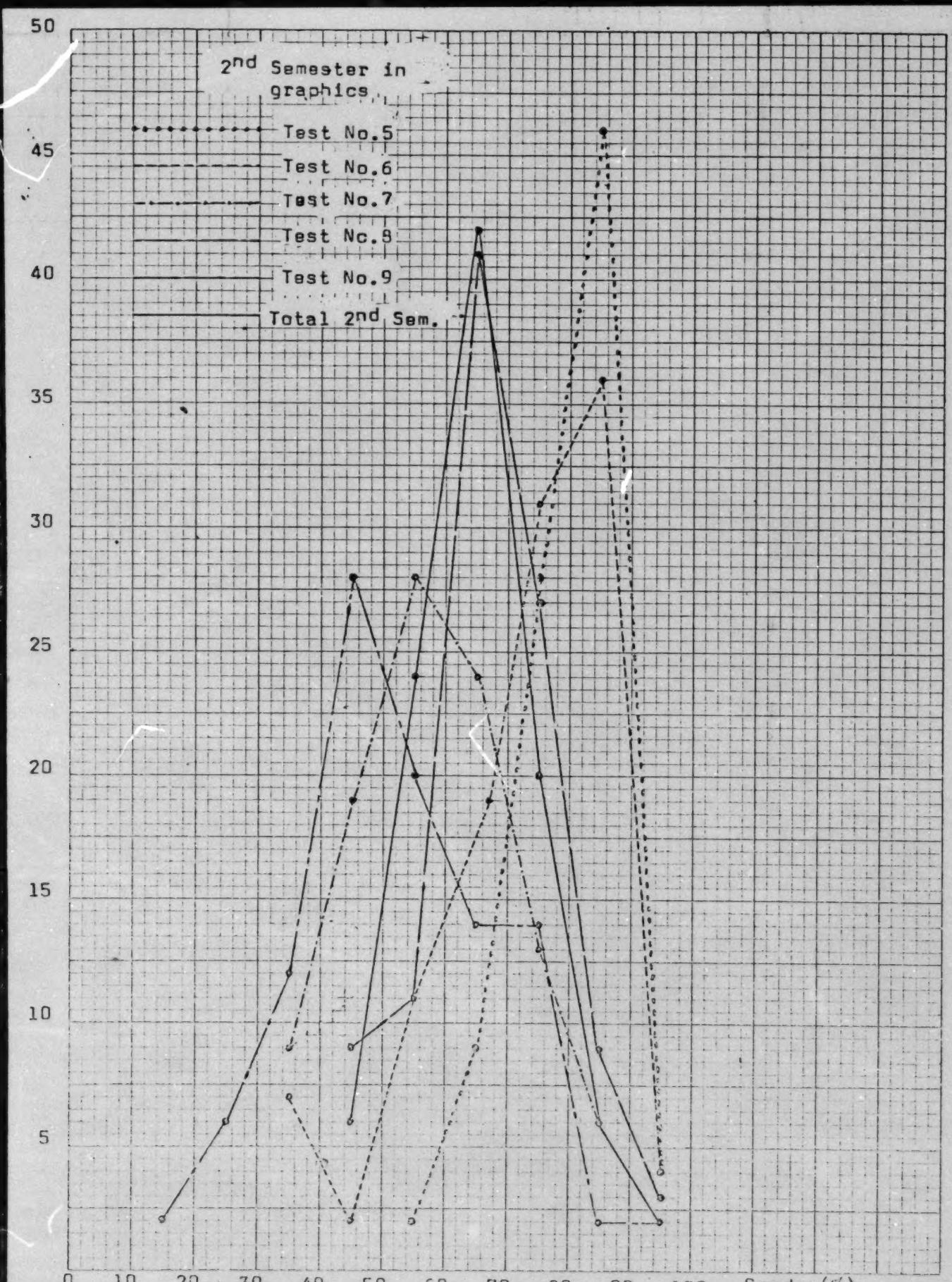

2nd Semester in graphics
Test No.5
Test No.6
Test No.7
Test No.8
Test No.9
Total 2nd Sem.
50
45
40
35
30
25
20
15
10
5
0
10
20
30
40
50
60
70
80
90
100
Grades(%)

FIG. 11 bis

Term Grades and Final Grades in Percents

First Semester			Second Semester			Mean both semesters		
N	F	F(%)	N	F	F(%)	N	F	F(%)
90	1	1.85	92	1	1.85	91	1	1.85
89	1	1.85	86	1	1.85	87	1	1.85
86	1	1.85	82	1	1.85	83	1	1.85
84	1	1.85	81	1	1.85	82	1	1.85
83	1	1.85	80	1	1.85	81	2	3.70
82	1	1.85	79	1	1.85	80	2	3.70
81	1	1.85	78	2	3.70	78	1	1.85
80	5	9.25	76	3	5.55	77	2	3.70
79	1	1.85	75	1	1.85	76	1	1.85
78	2	3.70	74	2	3.70	74	1	1.85
77	1	1.85	71	1	1.85	73	2	3.70
76	1	1.85	70	1	1.85	72	2	3.70
75	1	1.85	69	4	7.40	71	3	5.55
74	1	1.85	68	2	3.70	70	2	3.70
73	1	1.85	67	4	7.40	69	3	5.55
72	3	5.55	66	2	3.70	68	3	5.55
71	1	1.85	65	4	7.40	67	2	3.70
70	3	5.55	64	2	3.70	66	1	1.85
69	5	9.25	63	2	3.70	65	5	9.25
68	3	5.55	62	1	1.85	64	1	1.85
66	2	3.70	61	1	1.85	63	3	5.55
65	2	3.70	60	1	1.85	62	1	1.85
62	2	3.70	59	3	5.55	61	2	3.70
61	1	1.85	58	2	3.70	60	1	1.85
60	3	5.55	57	1	1.85	59	1	1.85
59	1	1.85	56	2	3.70	58	1	1.85
58	2	3.70	55	3	5.55	57	2	3.70
57	1	1.85	52	1	1.85	56	2	3.70
55	1	1.85	48	2	3.70	53	2	3.70
54	1	1.85	47	1	1.85	52	1	1.85
52	1	1.85				49	1	1.85
51	1	1.85						
50	1	1.85						

N : Grades(%) , F : Frequency . (No. of students considered:54)

1st Semester : Mean:70 , Median:70
2nd Semester : Mean:65 , Median:66
Both Semesters : Mean:68, Median:68

TABLE 10

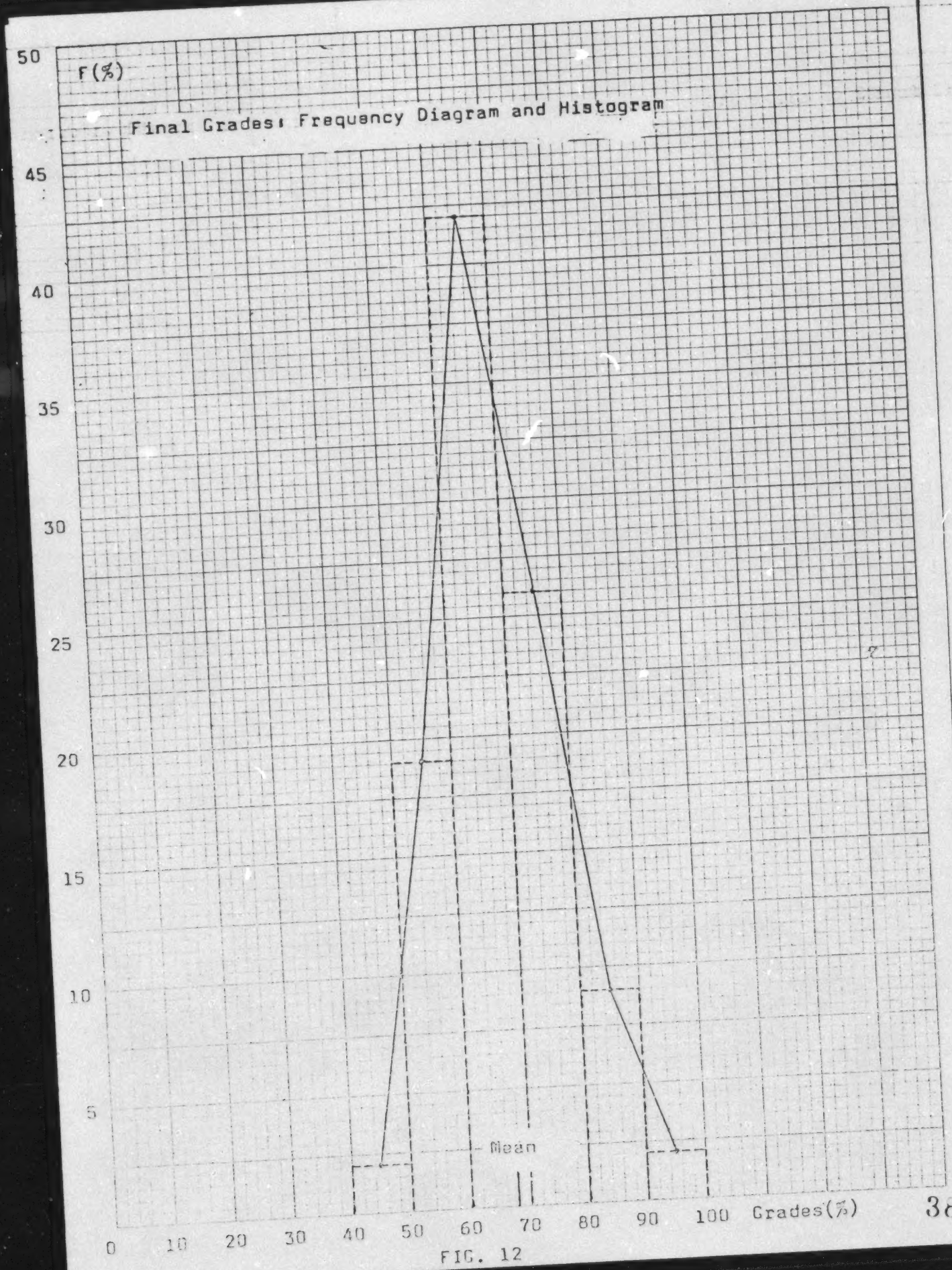

F(%)
Final Grades: Frequency Diagram and Histogram
50
45
40
35
30
25
20
15
10
5
Mean
0
10
20
30
40
50
60
70
80
90
100
Grades(%)

FIG. 12

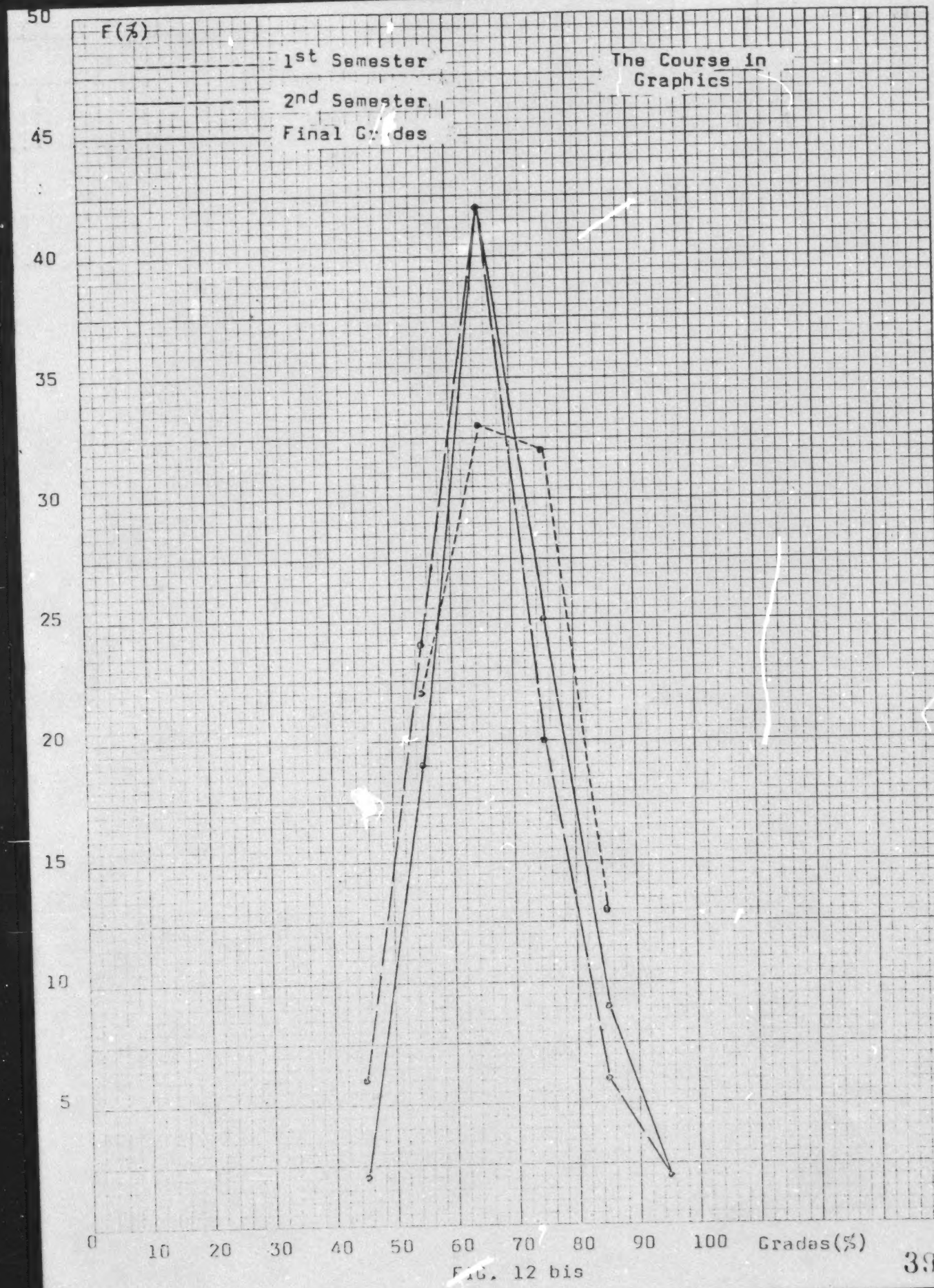

F(%)
1st Semester
2nd Semester
Final Grades
The Course in Graphics
50
45
40
35
30
25
20
15
10
5
0
10
20
30
40
50
60
70
80
90
100
Grades(%)

FIG. 12 bis

(5.55%), during the second semester, and 1 out of 54, (1.85%), for the complete course.

If we take 60% as the lower level of the C grade, the corresponding values as in the previous paragraphs are 11 out of 56, (19.64%), in the first semester, 15 out of 54, (27.77%), in the second semester, and 10 out of 54, (18.51) for the complete course.

In the equivalent regular courses the corresponding percentages of students with D, F or leaving the course are for the first semester, as shown in the following table.*

Year	Biology	Physics	Chemistry	N.S. Faculty
1969-70	32.4%	26.09%	42.7%	40.50%
1970-71	31.0%	28.55%	43.9%	38.80%
1970-71	29.9%	23.06%	40.0%	38.40%

The comparison between the data for the Faculty and that for the experimental program can be seen in an even clearer perspective if we take into account that the majority of the students do not normally take the three basic courses simultaneously.

It is, nevertheless, a very important factor when we come to consider the almost total absence of persons dropping the course, (two in the first semester and none in the second), in the interdisciplinary course compared to the 25% loss suffered by the different courses in Natural Sciences Faculty on an average

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* Annual report of the Faculty of Natural Sciences, UPR, Rio Piedras, 1971-72. Data was not available for the second semester or for the whole year.

during years 1969, 1970, and 1971. To drop the experimental course during the first semester assumed the delay at least of one semester in the date of graduation. To do this during the second semester would involve a delay in graduation of not less than one year.

In terms of material, the interdisciplinary course allowed the covering of a larger number of topics - in greater detail in many cases than is normally permitted by the structure of the separate courses. On the other hand, the experimental part was not intirely satisfactory, essentially due to lack of planning in the use of the physical facilities which caused the experiments to have to be carried out either in a hurry, or out of sequence. Nevertheless, it was noted that in the experiments taken from the regular laboratories, as well as in the three special projects under the charge of the graduate faculty, better numerical results were obtained, and the understanding of experiments was better than might have been expected. One fundamental reason for this is that all of the experiments were carried out in the second semester, when the student has the necessary background to understand without any great difficulty what is involved in the experiment.

One essential element of judgement at the moment of determining the success or failure of the experiment or course, is the quality of the participating students. A program with selected students has thereby a guarantee of not failing, especially if we remember that the participants in any educational experiment, given the special attention that they receive, are converted naturally into a select group with a feeling

of being "above average" no matter what might have been the quality of their previous preparation. In the case that we are considering, the group in itself was quite representative of the students admitted to the Natural Sciences Faculty, even in their future aspirations. In the adjoining table is shown the grade, (as a percentage), obtained by the students originally selected in the Mathematics section of the diagnostic entrance exam for the Faculty, as well as the major that they were thinking of following at that moment.

	GRADES (%)					
	51-60	61-70	71-80	81-90	91-100	
STUDENTS						
Number	14	13	23	9	1	
Percent	23	22	38	15	2	
Major	Biology	Physics	Math.	Chem.	Medicine	Undecided
Number	12	1	4	5	37	1
Percent	20	2	7	8	61	2

In the Mathematics section of the entrance examination the average for the Natural Sciences students was a little lower, due to the admission of students with grades below the originally recommended limit of 50%. Nevertheless, the percentage of the students admitted to Natural Sciences who were planning eventually to study medicine was slightly greater than those in the course, the numbers for the other majors being practically the same.

The unanimous impression of all of the participating professors in the program is that the students presented a lively

and active image, with a group spirit, and were more demanding than the normal sections that one meets in the Faculty at this level.

After the course was finished and their grades were officially registered, the participating students were offered an exam composed of questions used by the departments of Biology, Chemistry, and Physics in their exams during the two semesters of the academic year 1972-73. The results are shown in table 11. The exam was attended by 41 students, 13 were excused from attending since they were taking summer courses at the same time as the exam, or were out of the country. The difference between the number of students considered in the Biology, Chemistry, and Physics sections and in the total was due to mechanical problems in the correction of the exams.

It would be risky to draw quantitative conclusions from the results of this exam given the lack of precedent in the regular courses. Nevertheless, qualitatively it can be said that the results were far above the best expectations of the professors that prepared the exams. The averages correspond from lower to higher, to the order in which the different material was presented in the course. Physics was mostly grouped in the first semester, Biology in the second, with Chemistry bridging the gap between them. The exam was answered anonymously.

With the aim of polling the feelings of the students about the program, at the end of the course they were asked to submit anonymously written opinions over the course, putting principal emphasis on things which they had not liked, and points where

FINAL DIAGNOSTIC TEST

Biology			Physics			Chemestry			Total		
N	F	F(%)	N	F	F(%)	N	F	F(%)	N	F	F(%)
85	1	3.13	62	2	5.88	80	1	2.44	78	1	2.63
72	1	3.13	60	2	5.88	76	1	2.44	69	1	2.63
66	2	6.25	58	3	8.82	66	1	2.44	68	1	2.63
65	3	9.38	56	2	5.88	58	2	4.88	65	1	2.63
63	5	15.63	50	3	8.82	56	3	7.32	63	1	2.63
62	1	3.13	48	2	5.88	52	1	2.44	61	1	2.63
57	1	3.13	46	1	2.94	50	4	9.76	59	2	5.26
53	2	6.25	42	4	11.76	48	1	2.44	57	3	7.89
52	1	3.13	40	3	8.82	46	7	17.07	54	2	5.26
51	1	3.13	38	3	8.82	44	4	9.76	53	1	2.63
50	1	3.13	34	1	2.94	42	2	4.88	51	2	5.26
49	2	6.25	32	1	2.94	40	3	7.32	50	2	5.26
48	1	3.13	26	2	5.88	38	2	4.88	49	2	5.26
43	1	3.13	24	1	2.94	36	4	9.76	48	4	10.52
42	1	3.13	22	1	2.94	34	1	2.44	47	1	2.63
40	1	3.13	18	1	2.94	32	1	2.44	46	1	2.63
38	2	6.25	14	2	5.88	30	2	4.88	41	1	2.63
34	1	3.13				28	1	2.44	39	1	2.63
33	1	3.13							38	4	10.52
30	1	3.13							37	1	2.63
24	1	3.13							36	1	2.63
19	1	3.13							34	1	2.63
									25	1	2.63
									24	1	2.63
									21	1	2.63

N: Grades(%)
F: Frequency

No. of students considered: Biology part: 32
Physics part: 34
Chemestry part: 41
Whole Test : 38

The mean was, in : Biology : 52
Physics : 42
Chemestry: 46
Whole test:46

TABLE 11

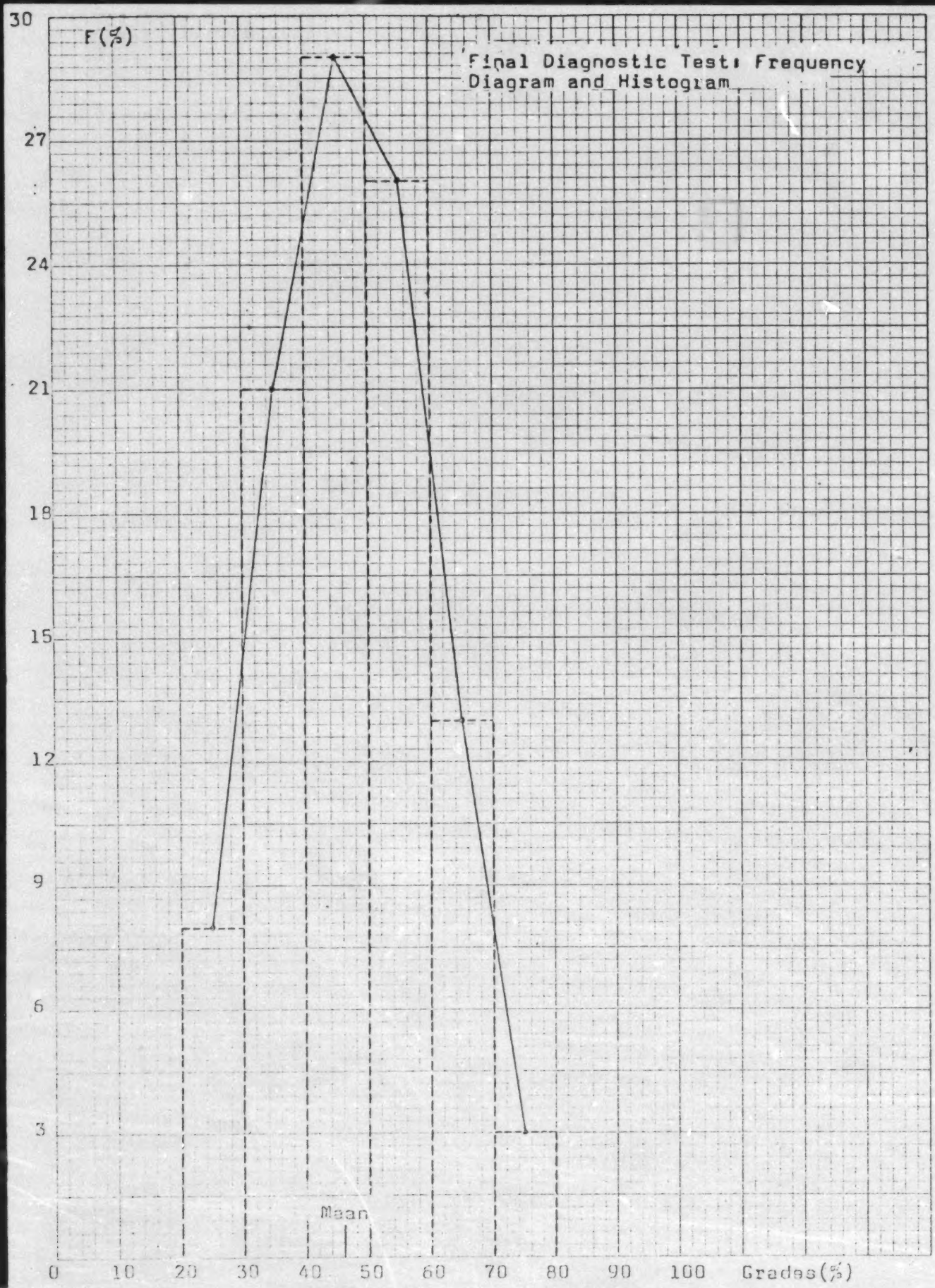
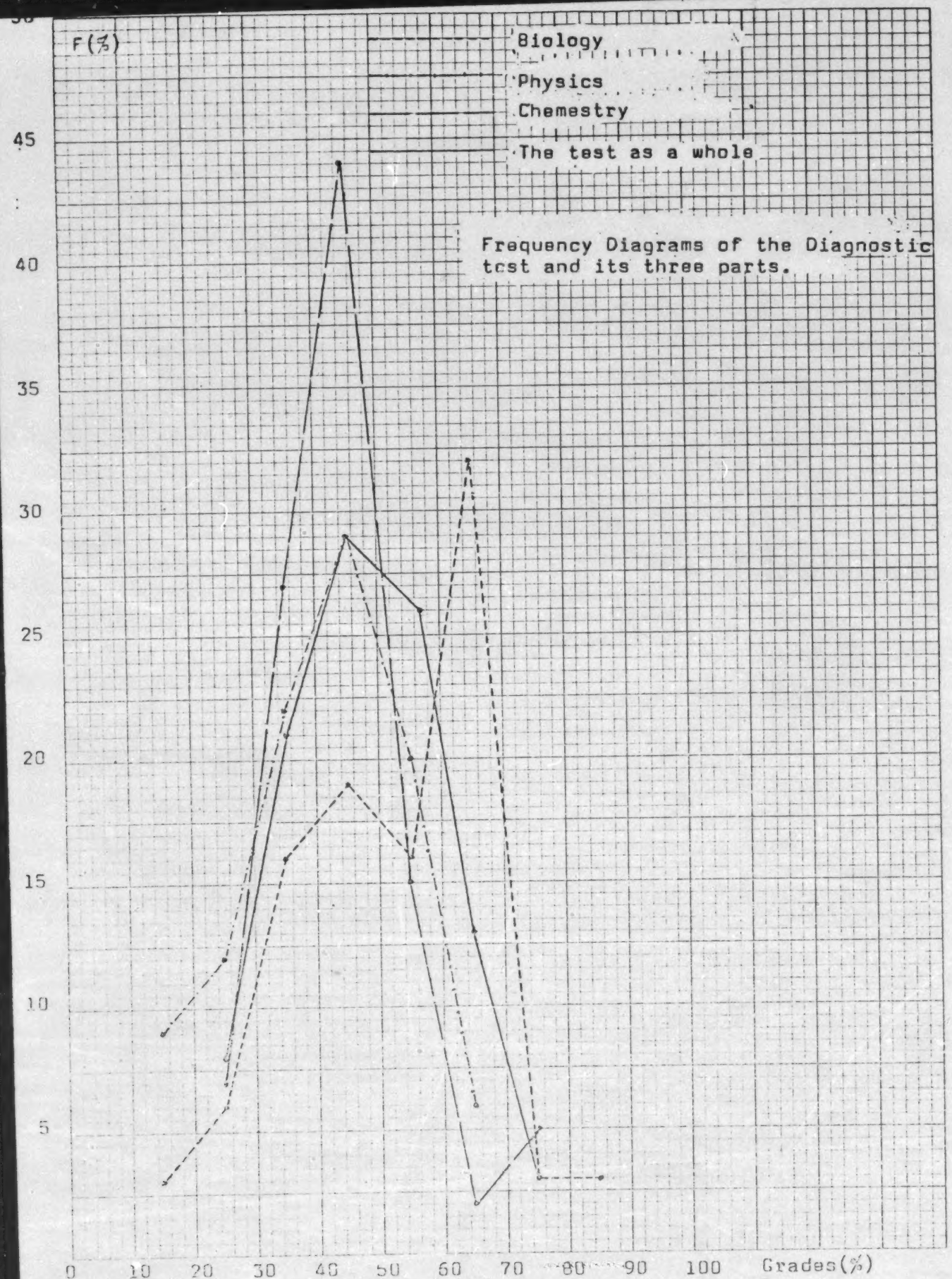

Final Diagnostic Test: Frequency Diagram and Histogram
F(%)
30
27
24
21
18
15
12
9
6
3
Mean
0
10
20
30
40
50
60
70
80
90
100
Grades(%)

FIG. 13



Frequency Diagrams of the Diagnostic test and its three parts.

FIG. 13 bis

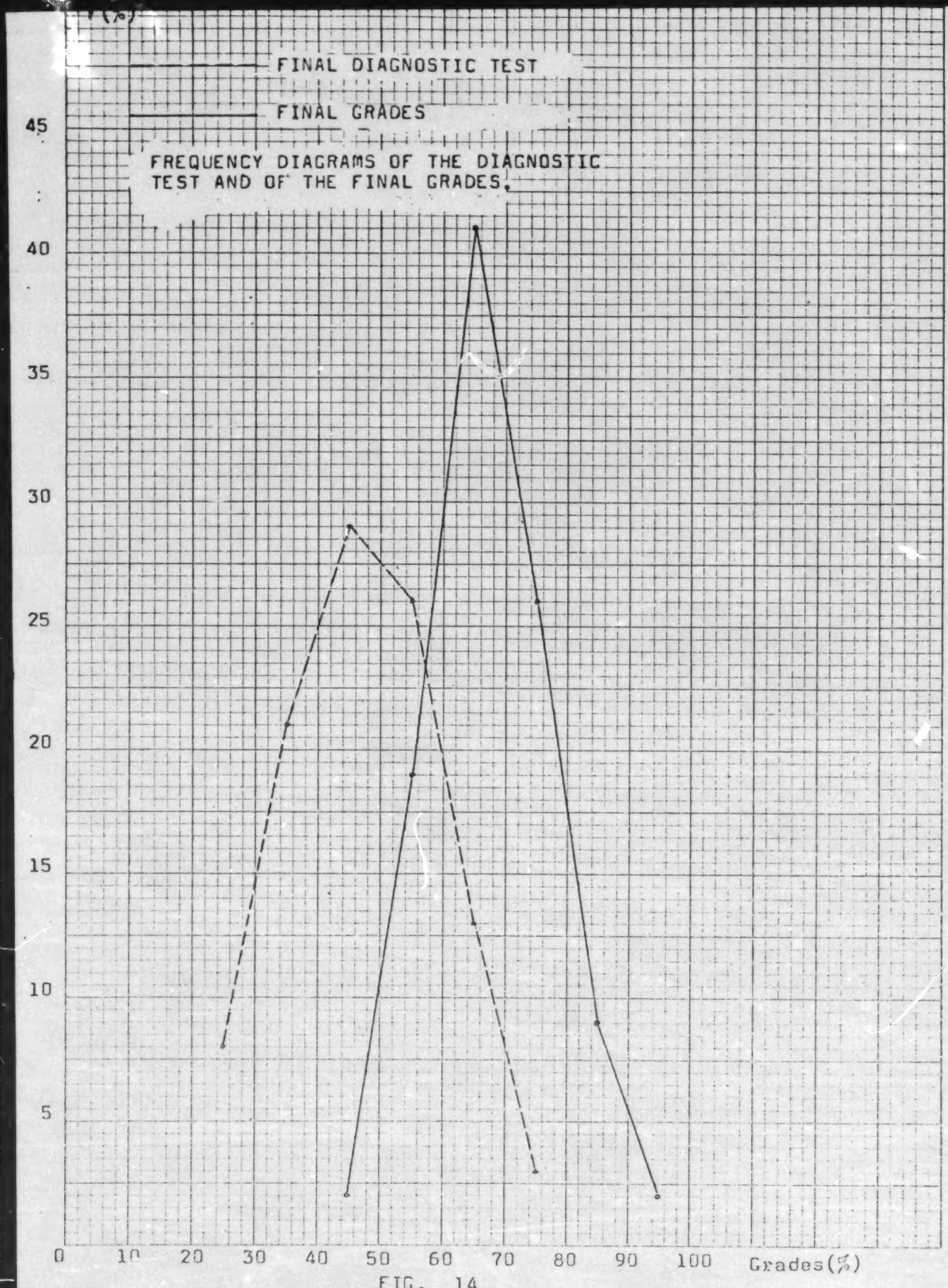

(%)
FINAL DIAGNOSTIC TEST
FINAL GRADES
FREQUENCY DIAGRAMS OF THE DIAGNOSTIC TEST AND OF THE FINAL GRADES.
45
40
35
30
25
20
15
10
5
0
10
20
30
40
50
60
70
80
90
100
Grades(%)

FIG. 14

the course should be improved. Twenty-one answers were received, surprisingly well written, with specific and clear observations and recommendations coinciding almost completely with those of the participating professors.

All praised the course and felt satisfied to have participated in it. All believed that they have finished with a better preparation than if they had followed the normal system except in one case, who found that he would have been the same. All indicated, as the principal defect, the lack of organization, the daily delay in the delivery of material and problem sets. All indicated the necessity of using the laboratory more, and of increasing the number of exams so that there should not be an accumulation of too much material for each one. All praised the use of invited lecturers, and some were sorry that these should not have been used with greater frecuency. Surprisingly, there were students who indicated that the program should have been more rigid, more disciplined, and less liberal with the participating students. In some cases it was suggested that students should be selected from among the best in the faculty, and that a smaller group should be used in teaching.

A point that is worthy of special attention is the perennial fear. In some cases it should be clasified as panic, which the students have of the grades in any period of the year, especially at the end of each semester. For all practical purposes the grades that the students receive in the basic courses in the second year decide how, when, and with what average he is going to graduate.

Consequently, at least the student believes that these grades will decide his future. In the normal system of separate courses, this average is produced in stages. In the case of the interdisciplinary course it is produced instantaneously, releaving the enormous and abnormal pressure which the grade average exerts over our students. The spectre of the School of Medicine haunts the faculty for the former. This is the reason why at the end of the course, faced with the imminent release of the grades, the students of the program organized themselves, using the most varied and valid arguments to convince the corresponding academic authorities that the students should only be graded with "pass" or "fail".

It will be premature at this moment to pass a definitive judgement on the value of the experimental course, without a previous follo-up of the participants which analyzes the subsequent work. This is a pending task for the next academic year.

5. Participating Professors

Program Director: Prof. Amador Cobas, Physics Department

Prof. Gladys Escalona de Motta, Biology Department

Prof. Alec Grimison, Chemistry Department

Prof. Manuel Torrens, Physics Department (2nd. semester)

Prof. Carlos Machin, Physics Department, (Coordinator)

Visiting Professors:

Prof. Hilda Aboy de Buso, Biology Department

Prof. Evelina Ortiz, Biology Department

Prof. Edna Mendez de Ortiz, Biology Department

Prof. Fernando Renaud, Biology Department

Prof. Larry Liddle, Biology Department

Prof. Luis Veguilla, Chemistry Department

Prof. Gerald Stevenson, Chemistry Department

Prof. Osvaldo Rodriguez, Chemistry Department

Prof. George Rubottom, Chemistry Department

Prof. Alfredo Torruella, Physics Department

Prof. Ronald Selsby, Physics Department

Prof. Richard Clemens, Puerto Rico Nuclear Center

Prof. Vilma Toro de Suarez, Bayamon Regional College, UPR

In this summary are included the professors who offered the special experimental projects.

3. Recommendations and Observations

The course should be offered again during the academic year 1974-75, the intermediate year should be used to refine the presentation of the topics, completely redesign the experimental section and prepare the printed material, lectures, problems sets, articles, etc., which are going to be handed over to the students. This will cure the most important faults, the laboratory and the organization of the written material, which were found in the first presentation of the interdisciplinary course.

If this recommendation is accepted it would be convenient to designate as soon as possible the fixed professors for the program, so that they could familiarize themselves with the course and introduce the variations which they feel necessary without pressure of time.

From the experience gained, the course can be developed using ten hours a week - two hour sections five days of the week - for two semesters, for a total of 18 credits, 9 per semester. This

will represent a reduction of five hours a week compared to the original course offered in the academic year 1972-73, and will free six credits for the different programs of the Faculty of Natural Sciences.

It is recommended that the experimental section be offered during the second semester in an intensive form in three hour sections, four days a week, from Monday thru Thursday, for ten weeks, giving a total of 120 hours in the laboratory. This would not carry separate credits and would be a requisite of the course.

It is convenient to continue the habit of using visiting lecturers in the presentation of certain special topics, since apart from the interest that this awakes in the students, they are offered a unique educational experience. In this sense the collaboration of the Graduate Faculty in the design and implementation of the experimental section, as well as the use of some of their equipment facilities, would be very valuable.

It is recommended that the course should be offered to voluntary students in number not less than 60, nor more than 100, divided into two sections. In this sense it would be useful if one of the sections were composed of second year students from the General Studies Faculty, and the other from students who have entered directly into the Faculty of Natural Sciences in their first year. For evaluating purposes it would be convenient that the participants should carry no less than 18 credits per semester, 12 in Natural Sciences Faculty and 6 in other faculties, which is the number of credits which the average students of Natural Sciences

take in their second year. This practice was followed during the presentation of the interdisciplinary course in the academic year 1972-73, since the participants took 9 credits in addition to those in the program. The preparation of fixed basic programs, so that the participating students would only have to add the elective assignments to these, would extraordinarily facilitate the subsequent work of evaluation in future years.

One point to indicate is that the greatest difficulty met within multidisciplinary courses such as the one we are discussing is the integration in a logical way of the descriptive sections of Biology. This is a problem whose solution is difficult, and that only time and the increasing use of Mathematics in Biology can help to solve.

Finally the preparation and implementation of the interdisciplinary course uncovered a series of problems which affect all programs in the Faculty, so that is useful to consider them in a certain amount of detail.

In the spring of 1971, of the 524 students who took the entrance exam for Natural Sciences, 64.31% - (337) - had intentions of studeying medicine or related careers, 19.28% - (101) - Biology, 4.96% - (26) - Chemistry, 3.05% - (16) - General Degree, 2.86% - (15) - Mathematics, 1.34 - (7) - Physics, and 0.58% - (3) Veterinary Studies. 3.62% - (19) - either did not know what they were going to do, or were not willing to state it. If we allow for the fact that a significant percentage of the students who express a desire to specialize think of subsequently going to the Medical School, it is possible to state that 70% or more of the human resources of the Faculty of Natural Sciences are committed at least

in principle to the Medical Studies. Considering that for the academic year 1973-74 of 470 qualified applicants, the School of Medicine could only admit 118, to which we have to add 100 admitted to schools in the United States, Dominican Republic, Mexico, and Spain*, we can conclude that the principal mission of the Faculty of Natural Sciences is, in fact, to act as a sieve for the Medical School.

Intimately linked to the previous is the problem of maintaining an index as close as possible to 4.00, not as a manifestation of knowledge, but rather as the key for access to graduate programs in general, and to Medicine in particular. Given that the average tends to drop substantially after the students have spent one year in the Faculty of Natural Sciences, the only alternative open to the student is to take the sections and assignments that the students slang qualifies, with or without truth, as "to raise their average". Given that the primary mission of the Faculty is formative, and only selective in the second instance, it is recommended that the possibility be studied of implementing a system of using "pass" or "fail" as the only grades in all the basic courses in the Faculty. This will permit a decrease of emphasis on the averages, the pressure of selection, and will increase the strictness

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*From information provided by Dr. H. Lugo, Director of the Office of Studies related to Medicine, certificates were provided for 79 students to study in the Dominican Republic, Mexico, and Spain. For the United States a certificate is not required, so that there are no exact numbers of the Students who might have moved to the mainland to continue their studies. However, given the requirements of the North American Medical Schools for admission, the total number of 100 students in Medicine, per year, outside of Puerto Rico seems a reasonable estimate.

This will have benefits in terms of a better education for the students, and contribute to the eradication of the current phobias with regard to the grade averages.

In the same vein, it would be convenient if the period of grace before droping a class, except in the case of a total abandonment, should be reduced to five weeks. Also the fail grades, or their equivalents F and D, should be removed from the students' academic transcript once the student has demonstrated his proficiency in the corresponding material.

The counseling system operating in the Faculty is in the best of cases, inefficient and in the worst, tragic. In practice, face to face with the student, counselors are simply dispensers of class tickets, and custodians of the Dean's seal in the matriculation period. It is recommended to study the possibility that the counseling system be transformed from an administrative one into an academic one, and that there should exist a direct relationship between the counselors at different levels, in such a way that there might be continuity in the advice given to the students when they pass from second to third, or to fourth year.

IV. Acknowledgements

The interdisciplinary course owes its existance to the dedication of a large number of people who altruistically offered their enthusiasm, their support, and their work.

Chronologically, the course owes a great debt, first with Dr. Amador Cobas, originator and moving force behing the program, and author of the proposal which resulted in the grant from HEW, which made possible the implementation of the course. Next with Dr. Ismael Almodovar, and the personnel of the Office of the Dean

of Natural Sciences, who supported the idea of an interdisciplinary program and helped in the process of selection and registration of the students for the course. Next, with the committee that prepared and administered the entrance exams for Natural Sciences in 1972 for their patience and collaboration in the process of recruiting students for the program. Then with the personnel of the different offices of the Faculty that provided material and reproduction equipment whenever it was possible for them to do so. Then with Drs. W. Adam and A. Grimison for permitting us to use and reproduce material from their personal files.

The course never would have been offered without the dedication, work and good humor, not only in the classroom but also outside, of professors Escalona de Motta, Grimison, Torrens and Machin, as well as the collaboration of the distinguished group of visiting lecturers, whose names are mentioned in a previous section of this report.

Finally, our most profound gratitude to the 54 students of the interdisciplinary course, for their faith and confidence in the program, for their patience and understanding when things didn't work out as they should, and above all for their work.

Amador Cobas

Dr. Amador Cobas
Program Director